

ROLLOVER WARNING (continued)

DERIVED REQUIREMENTS

Communication Mode - one-way - Beacon on Roadside.

Transaction Size -- 1024 bits.

Max. No. of Messages -- 3.

Max. Range -- > 100 ft .

Communication Zone Size -- 80 ft.

Beacon Separation Distance -- 200 ft.

EMERGENCY VEHICLE SIGNAL PREEMPTION

Emergency vehicle signal preemption is implemented with OBE mounted in intersections and communicating with Beacon equipped emergency vehicles as they approach. As a OBE collects data to identify an approaching emergency vehicle it sends information to the signal controller that allows the emergency vehicle to proceed through the intersection with a green light.

STAKEHOLDER REQUIREMENTS

General Position -- Yes.

Vehicle Detection -- Yes.

Vehicle Location -- No.

Lane Discrimination -- No.

Communications Performance -- 99.995 %.

Traffic Speed -- 0 to 120 mph.

Traffic Density -- 30 v/h/l typical max. (2400 v/h/l rate possible).

Min. Vehicle Separation -- 1 ft.

Min. OBE longitudinal separation -- **5** ft (motor cycles) / 16 ft (other).

Min. OBE lateral separation -- 3 ft (motor cycles) / 10 ft (other).

Beacon Density -- 1 per block.

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EMERGENCY VEHICLE SIGNAL PREEMPTION (continued)

STAKEHOLDER REQUIREMENTS (continued)

Where possible, install where power and structures already exist.
Typical Block Length -- 300 ft (90 m) (varies from 200 to >5280 ft).

Notify the signal controller to provide preemption (cycle to green) far enough in advance to clear the intersection before emergency vehicle arrival.

Notify the signal controller to provide priority (hold green) 3000 ft away or as soon as the emergency vehicle enters the typical block.

Notify the signal controller to stop providing priority (holding green) as soon as possible after the emergency vehicle clears the intersection.

Notify the signal controller when the priority is not needed (Emergency vehicle makes a turn off of the current prioritized corridor).

EMERGENCY VEHICLE SIGNAL PREEMPTION (continued)

DERIVED REQUIREMENTS

Communication Mode - Two-way - Beacon on the vehicle/ OBE on the roadside.

Transaction Size -- 2000 bits.

Max. No. of Messages -- 5.

Nominal Range -- 300 ft.

Max. Range -- 3000 ft.

Communication Zone Size -- 300 ft.

Nominal Beacon Separation Distance -- 300 ft.

Max. Range Beacon Separation Distance -- 3000 ft.

ASSUMPTION

Communicate with only the lead vehicle at range limit when traveling in convoy.

TRANSIT VEHICLE SIGNAL PRIORITY (Near Side Stop)

Transit vehicle signal priority is implemented with one or more beacons mounted in each priority providing intersection. These beacons communicate with OBE equipped transit vehicles as they approach the traffic signal. On the approach to the signal, at a specific distance, data from the transit vehicle is sent to the RSE near the signal. The beacon sends this data to the signal controller or interface device which determines whether the transit vehicle is to receive priority. If it is, the signal holds an existing green light (or turn signal) or advances the timing of a red light to bring the green (or turn signal) back up as soon as possible. If the transit vehicle makes a passenger stop in the block, the OBE sends data to the beacon to indicate when the transit vehicle is ready to depart from the passenger stop. If it is and the light is red the signal controller gives the transit vehicle a signal to proceed ahead of other traffic just before the light turns green. Once the transit vehicle is in the intersection, the OBE sends a checkout message so that the signal controller can return to its regular timing.

STAKEHOLDER REQUIREMENTS

General Position -- Yes.

Vehicle Detection -- Yes.

Vehicle Location -- No.

Lane Discrimination -- No.

Communications Performance -- 99.90 %.

Traffic Speed -- 0 to 70 mph.

Traffic Density -- 60 v/h/l typical max. (2400 v/h/l possible).

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TRANSIT VEHICLE SIGNAL PRIORITY

(Near Side Stop, continued)

STAKEHOLDER REQUIREMENTS (continued)

Min. Vehicle Separation -- 1 ft.

Min. OBE longitudinal separation -- 30 ft.

Min. OBE lateral separation -- 10 ft.

Beacon Density -- 1 per block.

Marketable price point -- < \$500 OBE

Install as few beacons in each intersection as possible.

Where possible, install where power and structures already exist.

Stops may occur every other block or every block.

The signal controller will provide priority only when necessary.

Typical Block Length -- varies from 200 to >5280 ft (300 ft [90 m] typical).

Notify the signal controller to provide priority (hold green) when the transit vehicle is not stopping in the block.

Notify the signal controller to provide an advance go, ahead of green, when ready to leave a passenger stop and the signal is red.

TRANSIT VEHICLE SIGNAL PRIORITY (Near Side Stop, continued)

STAKEHOLDER REQUIREMENTS (continued)

Notify the signal controller when the priority is not needed (Transit vehicle must stop when customer suddenly shows up at near side stop).

Notify the signal controller to stop providing priority (holding green) when the transit vehicle enters the intersection (checkout).

Communicate with every approaching transit vehicle.

Provide =>**10%** improvement in running time.

DERIVED REQUIREMENTS

Communication Mode - Two-way.

Transaction Size -- **1024**.

Max. No. of Messages -- **5** (for each communication instance.)

Max. Range -- **1000** ft.

Communication Zone Size -- **200** to **1000** ft (300 ft typical).

Beacon Separation Distance -- 200 to **1000** ft (300 ft typical).

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TRANSIT VEHICLE SIGNAL PRIORITY (Far Side Stop)

Transit vehicle signal priority is implemented with one or more beacons mounted in each priority providing intersection. These beacons communicate with OBE equipped transit vehicles as they approach the traffic signal. On the approach to the signal, at a specific distance, data from the transit vehicle is sent to the beacon near the signal. The beacon sends this data to the signal controller or interface device which determines whether the transit vehicle is to receive priority. If it is, the signal holds an existing green light (or turn signal) or advances the timing of a red light to bring the green (or turn signal) back up as soon as possible. Once the transit vehicle is in the intersection, the OBE sends a checkout message so that the signal controller can return to its regular timing.

STAKEHOLDER REQUIREMENTS

General Position -- Yes.

Vehicle Detection -- Yes.

Vehicle Location -- No.

Lane Discrimination -- No.

Communications Performance -- 99.90 %.

Traffic Speed -- 0 to 70 mph.

Traffic Density -- 60 v/h/l typical max. (2400 v/h/l possible).

TRANSIT VEHICLE SIGNAL PRIORITY

(Far Side Stop, continued)

STAKEHOLDER REQUIREMENTS (continued)

Min. Vehicle Separation -- 1 ft.

Min. OBE longitudinal separation -- 30 ft.

Min. OBE lateral separation -- 10 ft.

Beacon Density -- 1 per block.

Marketable price point -- < **\$500** OBE

Install as few beacons in each intersection as possible.

Where possible, install where power and structures already exist.

Stops may occur every other block or every block.

The signal controller will provide priority only when necessary.

Typical Block Length -- varies from 200 to >5280 ft (660ft [200m] typical).

Notify the signal controller to provide priority (hold green or advance to green) when the transit vehicle merges back into traffic after its passenger stop or is not stopping in the block.

Notify the signal controller to stop providing priority (holding green) when the transit vehicle enters the intersection (checkout).

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TRANSIT VEHICLE SIGNAL PRIORITY (Far Side Stop, continued)

STAKEHOLDER REQUIREMENTS (continued)

Communicate with every approaching transit vehicle.

Provide =>10% improvement in running time.

DERIVED REQUIREMENTS

Communication Mode - Two-way.

Transaction Size -- 1024.

Max. No. of Messages -- 5 (for each communication instance.)

Max. Range -- 1000 ft.

Communication Zone Size -- 200 to 1000 ft (660 ft typical).

Beacon Separation Distance -- 200 to 1000 ft (660 ft typical).

INTERSECTION COLLISION AVOIDANCE

Intersection collision avoidance is implemented with beacons mounted at signalized intersections and communicating with OBE equipped vehicles as they approach. The beacon sends messages to the OBE that contain the state and timing of the signal. The vehicle computer then uses this information to compare the vehicle's position and speed to the timing of the signal and provide a warning if vehicle will not be able to clear the intersection in time.

STAKEHOLDER REQUIREMENTS

General Position -- Yes.
Vehicle Detection -- No.
Vehicle Location -- No.
Lane Discrimination -- No.
Communications Performance -- 99.995 %.
Traffic Speed -- 120 mph.
Traffic Density -- 3000 v/h/1.

INTERSECTION COLLISION AVOIDANCE (continued)

STAKEHOLDER REQUIREMENTS (continued)

Min. Vehicle Separation -- 1 ft.
Min. OBE longitudinal separation -- **16** ft.
Min. OBE lateral separation -- 7 ft.
Beacon Density -- 1 each intersection.

DERIVED REQUIREMENTS

Communication Mode - One-way - Beacon at the signal.
Transaction Size -- **256** bits.
Max. No. of Messages -- **1** every **100** ms .
Max. Range -- 1000 ft.
Communication Zone Size -- varies from **200** to **1000** ft.
Longitudinal Beacon Separation Distance -- varies from 200 to **>5280** ft.
Lateral Beacon Separation Distance -- 200 to **>5280** ft.

HIGHWAY/RAIL INTERSECTION WARNING

Highway/Rail intersection warning refers to the display (and annunciation, where necessary) of railroad crossing warning and train approaching information inside the vehicle. Antennas mounted in railroad warning sign structures deliver the warning data.

STAKEHOLDER REQUIREMENTS

General Position -- Yes.

Vehicle Detection -- Yes.

Vehicle Location -- Yes.

Lane Discrimination -- Yes.

Communications Performance -- 99.995 %.

Traffic Speed -- 0 to 120 mph.

Traffic Density -- 3000 v/h/l - (1 to 8 lanes).

Min. Vehicle Separation -- 1 ft.

Min. OBE longitudinal separation -- 16 ft.

Min. OBE lateral separation -- 10 ft.

Sign Density -- 1 for each traffic flow direction at each railroad crossing.

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HIGHWAY/RAIL INTERSECTION WARNING (continued)

STAKEHOLDER REQUIREMENTS (continued)

Pass warning data in time for the average driver to take the proper action at all road design speeds (0 to **65** mph). Do not add additional road hazards (posts) on the roadside, if it can be avoided. Where possible, install beacons on existing warning structures.

Install beacons beside the roadway with the proper lateral clearance in accordance with the Manual on Uniform Traffic Control Devices.

DERIVED REQUIREMENTS

Communication Mode - ONE-WAY - Beacon on Roadside

Transaction Size -- **500** bits.

Max. No. of Messages -- 5.

Max. Range -- **1000** ft.

Communication Zone Size -- **20** to **100** ft.

Beacon Separation Distance -- Max. Range of preceding beacon. **125** to 1000 ft.

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ACCESS CONTROL

Access control is implemented by installing beacons at the entry and exit points of restricted areas, such as shipping yards, warehouses, airports, transit -only ramps and other areas. The beacons collect an identity code or access code from approaching OBE equipped vehicles and transmit a message to proceed or that entry is not allowed. The message could be displayed in the vehicle via in-vehicle signing.

STAKEHOLDER REQUIREMENTS

General Position -- Yes.

Vehicle Detection -- Yes.

Vehicle Location -- Yes.

Lane Discrimination -- Yes.

Communications Performance -- 99.995 %.

Traffic Speed -- 0 to 30 mph.

Traffic Density -- 1200 v/h/l typical max. (2400 v/h/l possible).

Min. Vehicle Separation -- 1 ft.

Min. OBE longitudinal separation -- 30 ft.

Min. OBE lateral separation -- 10 ft.

Beacon Density -- 10 per installation.

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ACCESS CONTROL

(continued)

DERIVED REQUIREMENTS

Communication Mode - Two-way - Beacon on Roadside.

Transaction Size -- 128 DL/256 UL bits.

Max. No. of Messages -- 5.

Max. Range -- 50 ft.

Communication Zone Size -- 40 ft.

Longitudinal Beacon Separation Distance -- 600 ft.

Lateral Beacon Separation Distance -- 10 ft.

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VEHICLE AND CARGO TRACKING

Vehicle and cargo tracking is implemented by installing beacons at the entry and exit points of shipping areas, such as shipping yards, warehouses, airports, and other areas. The beacons collect an identity code and, if desired, a cargo list from approaching or leaving OBE equipped vehicles and send that information to a tracking program. Tracking information can also be obtained from the beacon data of weigh-station clearance points and border crossings.

STAKEHOLDER REQUIREMENTS

General Position -- Yes.

Vehicle Detection -- Yes.

Vehicle Location -- Yes.

Lane Discrimination -- Yes.

Communications Performance -- 99.995 %.

Traffic Speed -- Nominally 0 to 60 mph (0 to 120 mph possible).

Traffic Density -- 2400 v/h/l.

Min. Vehicle Separation -- 1 ft.

Min. OBE longitudinal separation -- 30 ft.

Min. OBE lateral separation -- 10 ft.

Beacon Density -- 5 per installation.

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VEHICLE AND CARGO TRACKING (continued)

DERIVED REQUIREMENTS

Communication Mode - Two-way - Beacon on Roadside.

Transaction Size -- 80 DL/2000 UL bits.

Max. No. of Messages -- 10.

Max. Range -- 50 ft.

Communication Zone Size -- 40 ft.

Longitudinal Beacon Separation Distance -- 600 ft.

Lateral Beacon Separation Distance --10 ft.

WEIGH-STATION CLEARANCE (MAINLINE SCREENING)

Weigh-station clearance (mainline screening) is implemented by using weigh-in-motion equipment in the road and beacons mounted beside the road to weight, identify and determine legal weight or overweight conditions. This technology allows the agency that is collecting and analyzing data to easily and quickly transfer that data to and from a specific vehicle moving through the communications zone of the checkpoint at a high rate of speed. Also, in-vehicle signing can be used to advise the driver how to proceed. If the vehicle is given the pull-in message, it may be only weighted and allowed to proceed or it may be given a safety inspection.

STAKEHOLDER REQUIREMENTS

General Position -- Yes.

Vehicle Detection -- Yes.

Vehicle Location -- Yes.

Lane Discrimination -- Yes.

Communications Performance -- 99.995 %.

Traffic Speed -- 1 to 120 mph.

Traffic Density -- 1200 v/h/l typical max. (2400 v/h/l possible).

Min. Vehicle Separation -- 1 ft.

Min. OBE longitudinal separation -- 30 ft.

Min. OBE lateral separation -- 10 ft.

Beacon Density -- 5 per installation.

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WEIGH-STATION CLEARANCE (MAINLINE SCREENING) (continued)

DERIVED REQUIREMENTS

Communication Mode - Two-way - Beacon on Roadside.

Transaction Size -- 1500 DL/500 UL bits.

Max. No. of Messages -- 5.

Max. Range -- 100 ft.

Communication Zone Size -- 80 ft.

Beacon Separation Distance -- 600 ft.

INTERNATIONAL BORDER CLEARANCE

International border clearance is the process of electronically transferring data between a commercial vehicle and the border checkpoint so that the vehicle can pass the checkpoint with minimal or no delay. The vehicle is usually precleared at the loading dock, where the cargo is sealed by a lock tag and a clearance code entered into the tractor OBE. The clearance code and lock tag function are verified at the border by a roadside beacon.

STAKEHOLDER REQUIREMENTS

The international border clearance DSRC system must:

Detect an approaching vehicle

Locate the approaching vehicle

Transfer data reliably

Allow non-stop, roll-through operations,

Support other ITS applications

Have competing sources

Not have time lags between message transmission and message receipt

These requirements were obtained from the article "Tagged for trade, A technology survey for commercial border clearance", by George Atalla, in the Traffic Technology International Magazine, Dec '98/ Jan '99 issue.

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INTERNATIONAL BORDER CLEARANCE (continued)

STAKEHOLDER REQUIREMENTS (continued)

The international border clearance DSRC system must also be:

Multimodal (road, rail, and water way [canal, river, or port])

Installable at all border crossings (no site configuration incompatibilities)

Easy to use

Maintainable

Reliable

Scalable

Secure

Readily available (short times between order and delivery for installation)

Immune* (highly resistant) to signal interference

(*No communication system can be immune to interference)

INTERNATIONAL BORDER CLEARANCE (continued)

STAKEHOLDER REQUIREMENTS (continued)

General Position -- Yes.

Vehicle Detection -- Yes.

Vehicle Location -- Yes.

Lane Discrimination -- As necessary.

Communications Performance -- 99.995 %.

Traffic Speed -- 0 to 120 mph.

Traffic Density -- 1200 v/h/l typical max. (2400 v/h/l possible)

Min. Vehicle Separation -- 1 ft.

Min. OBE longitudinal separation -- 30 ft.

Min. OBE lateral separation -- 10 ft.

Beacon Density -- 5 per installation.

INTERNATIONAL BORDER CLEARANCE (continued)

DERIVED REQUIREMENTS

Communication Mode - Two-way - Beacon on Roadside.

Transaction Size -- 128 DL/256 UL bits.

Max. No. of Messages -- 5.

Max. Range -- 100 ft.

Communication Zone Size -- 10 to 80 ft.

Beacon Separation Distance -- 600 ft.

ON-BOARD SAFETY DATA

The on-board safety data can include engine performance data, brake data, and information on other important vehicle systems. It is stored in the vehicle OBE. This data can be read by a hand-held or permanently mounted reader while the vehicle has been pulled off the highway at a fixed or mobile inspection site or at the fleet service yard. The on-board safety data can also be read by mainline screening sites or other locations while the vehicle is in motion.

STAKEHOLDER REQUIREMENTS

General Position -- Yes.

Vehicle Detection -- Yes.

Vehicle Location -- Yes.

Lane Discrimination -- Yes.

Communications Performance -- 99.995 %.

Traffic Speed -- Nominally 0 to 70 mph (0 to 120 mph possible).

Traffic Density -- 1200 v/h/l.

Min. Vehicle Separation -- 1 ft.

Min. OBE longitudinal separation -- 30 ft.

Min. OBE lateral separation -- 10 ft.

Beacon Density -- 5 per installation.

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ON-BOARD SAFETY DATA (continued)

DERIVED REQUIREMENTS

Communication Mode - Two-way - Beacon on Roadside.

Transaction Size -- 80 DL/variable, up to **5** Meg, UL bits (2000 limit for mobile OBE).

Max. No. of Messages -- limited by UL size.

Max. Range -- **50** ft (handheld unit) and 100 ft highway.

Communication Zone Size -- 40 ft stationary OBE or 80 ft for mobile OBE.

Longitudinal Beacon Separation Distance -- 600 ft.

Lateral Beacon Separation Distance --**10** ft.

UNIQUE CVO FLEET MANAGEMENT

A DSRC fleet management application would allow fleet or individual operators to extract or upload data to and from commercial vehicles to support fleet management functions. Beacon readers could be placed at many locations, including terminals, warehouses, fueling facilities, commercial scales, and truck stops.

STAKEHOLDER REQUIREMENTS

General Position -- Yes.

Vehicle Detection -- Yes.

Vehicle Location -- Yes.

Lane Discrimination -- As necessary.

Communications Performance -- 99.995 %.

Traffic Speed -- 0 to 120 mph.

Traffic Density -- 1200 v/h/l.

Min. Vehicle Separation -- 1 ft.

Min. OBE longitudinal separation -- 30 ft.

Min. OBE lateral separation -- 10 ft.

Beacon Density -- ? per installation.

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UNIQUE CVO FLEET MANAGEMENT (continued)

DERIVED REQUIREMENTS

Communication Mode - Two-way • Beacon on Roadside.

Transaction Size -- 80 DL/variable , up to **5** Meg, UL bits (2000 limit for mobile OBE).

Max. No. of Messages -- limited by UL size.

Max. Range -- **50** ft (handheld unit) and 100 ft. highway.

Communication Zone Size -- 40 ft stationary OBE or 80 ft for mobile OBE.

Longitudinal Beacon Separation Distance -- 600 ft.

Lateral Beacon Separation Distance --**10** ft.

TOLL COLLECTION

In electronic toll collection (ETC), data is transferred from and to the vehicle's OBE, while the vehicle is in a toll area, and the toll fee is automatically deducted from the driver's toll account or other monetary account. Beacons are installed so that the toll collection agency can positively identify the location of the vehicle both at the time of the toll transaction and when the vehicle enters the toll road, ensuring that the driver is billed correctly.

STAKEHOLDER REQUIREMENTS

General Position -- Yes.

Vehicle Detection -- Yes.

Vehicle Location -- Yes.

Lane Discrimination -- Yes.

Communications Performance -- 99.995 %.

Traffic Speed -- 0 to 120 mph.

Traffic Density -- 3000 v/h/l.

Min. Vehicle Separation -- 1 ft.

Min. OBE longitudinal separation -- 6 ft (motor cycles) / **16 ft (other)**.

Min. OBE lateral separation -- 3 ft (motor cycles) / 10 ft (other).

Beacon Density -- 1 beacon or antenna per lane.

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TOLL COLLECTION

(continued)

DERIVED REQUIREMENTS for LANE BASED TOLL COLLECTION

Communication Mode - Two-way - Beacon above lane.

Transaction Size -- 512 DL/512 UL bits.

Max. No. of Messages -- **5**.

Max. Range -- 30 ft.

Communication Zone Size -- 7 ft.

Longitudinal Beacon Separation Distance -- 300 ft.

Lateral Beacon Separation Distance --10 ft.

DERIVED REQUIREMENTS for OPEN ROAD TOLL COLLECTION

Communication Mode - Two-way - Beacon above lane.

Transaction Size -- 512 DL/512 UL bits.

Max. No. of Messages -- 5.

Max. Range -- 100 ft.

Communication Zone Size -- 7 to 80 ft.

Longitudinal Beacon Separation Distance -- 600 ft.

Lateral Beacon Separation Distance --10 ft.

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PARKING PAYMENT

The parking payments application allows a vehicle to enter and exit a parking area while the parking fee is automatically deducted from the driver's parking account or other monetary account. The beacons are installed so that the parking agency can positively identify the location of the vehicle both at the time of the payment transaction and when the vehicle enters the parking area, ensuring that the driver is correctly billed.

STAKEHOLDER REQUIREMENTS

General Position -- Yes.

Vehicle Detection -- Yes.

Vehicle Location -- Yes.

Lane Discrimination -- Yes.

Communications Performance -- 99.995 %.

Traffic Speed -- 0 to 30 mph.

Traffic Density -- 3000 v/h/l.

Min. Vehicle Separation -- 1 ft.

Min. OBE longitudinal separation -- 6 ft (motor cycles) / 16 ft (other).

Min. OBE lateral separation -- 3 ft (motor cycles) / 10 ft (other).

Beacon Density -- 1 beacon or antenna per lane.

A